EVALUATION OF UNCERTAINTY IN INFILTRATION SCENARIOS AT YUCCA MOUNTAIN, NEVADA

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RESEARCH OBJECTIVES

An accurate estimate of infiltration rates is critical for the performance assessment of geological disposal of the high-level nuclear wastes at Yucca Mountain. The key components considered in the current infiltration model for Yucca Mountain include climate information, water transport and storage in the shallow zone, evapotranspiration, and surface runon and runoff. As a result of the uncertainty in the input parameters, 40 different infiltration maps were generated with the same probability of occurrence. However, the estimated infiltration maps are subject to some uncertainties due to the fact that the infiltration model was developed without consideration of subsurface data, such as temperature and chloride concentration measurements.

APPROACH

We developed an approach based on the generalized likelihood uncertainty estimate (GLUE) methodology (Beven and Binley, 1992). The GLUE procedure requires a definition of a likelihood measure to quantify how well each infiltration map reproduces the measured data. For each infiltration map, a process model is used to simulate water percolation, chloride transport, and heat transfer within the Yucca Mountain unsaturated zone. The simulation results are compared to the observed data to evaluate the likelihood function. A higher weighting factor is assigned to infiltration maps that more closely reproduce the data. Because of the inherent subjectivity in the choice of a likelihood function, the use of GLUE introduces a new type of uncertainty: the epistemic uncertainty in the analysis. To consider this uncertainty, we extended GLUE to use multiple likelihood measures and combine the results. The proposed likelihood functions cover a certain range of different functional types. The final weighting factor is an average of the weighting factors calculated from all the selected likelihood functions.

ACCOMPLISHMENTS

An effort was made in this study to handle the uncertainties in defining the likelihood function in the GLUE procedure. Specifically, four likelihood measures, each having a different evaluation focus and addressing a different aspect of model behavior, were chosen to assign weighting factors for the selected infiltration maps. Although the results from these likelihood functions varied, they consistently assign higher weights to the same infiltration maps. The final averaged weighting factors and their uncertainties were determined to weigh infiltration scenarios in the probabilistic performance assessment calculation.

SIGNIFICANCE OF FINDINGS

Net infiltration is a key hydrologic parameter for controlling percolation rate, groundwater recharge, potential seepage into waste emplacement drifts, and radionuclide transport—and therefore a key parameter in evaluating repository performance at Yucca Mountain. The GLUE method was developed to constrain the infiltration-rate uncertainties by using additional subsurface data collected from the unsaturated zone. Although the study is done for a specific setting, it provides a general framework from which to consider different types of uncertainty in environmental applications.

RELATED PUBLICATIONS

Beven, K., and A. Binley, The future of distributed models: Model calibration and uncertainty prediction. Hydrological Processes, 6, 279–298, 1992.

Wu, Y-S., et al., UZ Flow Models and Submodels, MDL-NBS-HS-000006, REV 03, June 2007.

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